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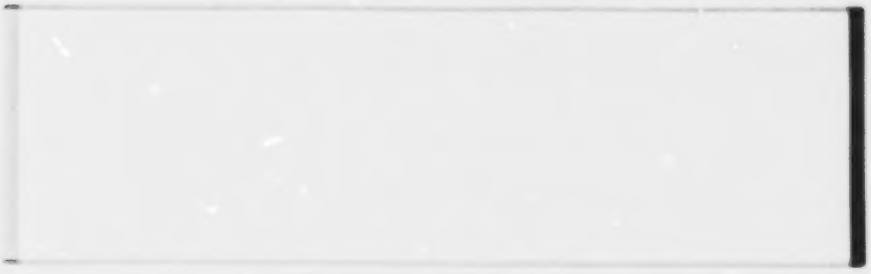

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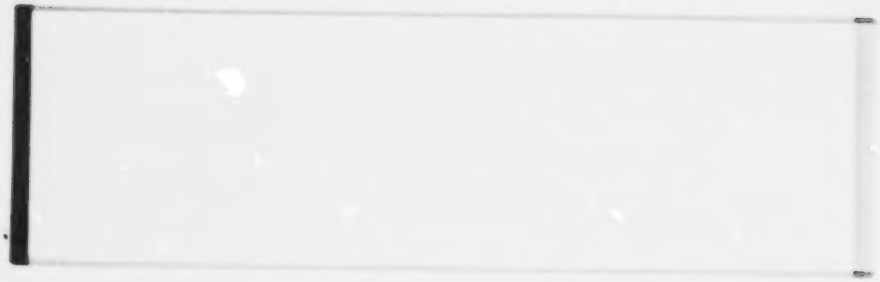

EQUIPMENT MONITORING AT SMOKY RIVER COAL MINE: TRIP REPORT

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MICROMEDIA

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EQUIPMENT MONITORING AT SMOKY RIVER COAL MINE: TRIP REPORT

by

V. Srajer*.

ABSTRACT

The Smoky River mine in Grande Cache, Alberta was visited by the author in August 1988. The purpose of the visit was to view and discuss installation and operation of the engine protection system developed by Ropec Industries Ltd. of Vancouver, B.C. The system consists of a controller, annunciator, battery relay, and uses a network of sensors to monitor engine parameters. This system was successfully tested at the mine site and is installed now at all mine trucks.

During the visit, the Legaloader III load weighing system, developed by Kilo-Wate, Inc. of Georgetown, Texas, that was installed on one of the front end loaders, was also examined. This system was not operational and is described here for information purposes only.

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INSPECTION DE L'ÉQUIPEMENT À LA MINE DE CHARBON DE SMOKEY RIVER: COMPTE RENDU DE VISITE

par

V. Strajer

RÉSUMÉ

En août 1988, l'auteur a visité la mine de Smokey River à Grande Cache (Alberta). Cette visite visait à prendre connaissance et à discuter de l'installation et de l'exploitation du système de protection des moteurs mis au point par la Ropec Industries Ltd. de Vancouver (C.-B.). Ce système est composé d'un dispositif de commande, d'un avertisseur acoustique, d'un relais de batterie et d'un réseau de capteurs pour surveiller certains paramètres de moteur. Il a été mis à l'épreuve avec succès dans la mine et tous les camions de la mine en sont maintenant équipés.

Au cours de cette visite, le système de pesée Legaloader III, mis au point par la Kilo-Wate, Inc. de Georgetown (Texas) qui été installé sur l'une des chargeuses frontales a également été examiné. Xomme il n'était pas opérationnel, ce système n'est décrit dans le présent document qu'à titre d'information.

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INTRODUCTION

The surface mine operations of Smoky River Coal Co. are located approximately 22 km from the plant site, situated 18 km north of town of Grande Cache in Alberta.

Coal is recovered from Nos. 4, 10 and 11 seams on both flanks of the McEvoy Anticline and the "A" and "B" ridge anticlines. Benches are developed 15 m high until the stripping approaches the coal seam. At this point 12 m benches are used down to the coal.

One Bucyrus-Erie 60R (31 cm diameter hole) and two Bucyrus-Erie 45R (25 cm diameter hole) drills are used to drill the overburden. The rock is blasted using bulk AN/FO and on site mixed ammonium nitrate slurry. The broken material is loaded by 11.5 m^3 P&H-2100 BL electric shovels into 135 tonnes Unit Rig and Terex rear dump trucks for disposal on waste dumps. A Caterpillar 992 front end loader and Unit Rig M-85 or Caterpillar 777 trucks are used to load and remove material from several confined areas not amenable to shovel operation. The coal is not blasted. Loading is done by Caterpillar 992 front end loaders and hauling by Caterpillar 773 trucks with 45 m^3 coal boxes. Caterpillar D9G dozers are used to rip the coal.

The raw coal is trucked 7 km from the pits to the breaker station in the Sheep Creek Valley, a descent of approximately 61 metres. The coal is then transported to the coal preparation plant by a 4.3 km long conveyor system which passes through a 3 km long tunnel through the Horse Mountain.

There are five BE-2100 BL electric shovels and five Caterpillar 992B front end loaders used to load material at the mine, and fourteen Unit Rig M33, ten Terex 33-15, three Unit Rig M35, three Caterpillar 777 trucks used for waste hauling, and eight Caterpillar 773 trucks used for coal hauling.

The Ropec, a vital sign monitoring system for off-highway vehicles was installed and tested at the mine in 1987. The system is now fully operational and is installed on all off-highway trucks. A front end loader weighing system, the Legaloader III was also purchased and installed on one unit. The system did not fulfill its expectation and is no longer used.

In this report, Ropec system, its operation and function of the sensors, is explained. The Legaloader system is described for information only.

ROPEC SYSTEM

System Operation

The Ropec is a safety unit that monitors the operation of the engine, displays the possible cause of a malfunction and, if the condition persists, initiates the orderly and safe shut down of the engine.

The control unit consists of three major subsections:

1. The sensors or transducers.

The external sensors are for fire, water temperature, water level, motion, gas, and over-speed, and indicate dangerous conditions by closing a connection between ground and the terminal block on the printed circuit card. The motion sensor closes the contact when the vehicle speed drops below approximately 10 km/h. The internal sensor (tilt switch) closes a contact when the vehicle tips over more than 60 degrees. The START and KEY switches produce start up and shut down sequences by providing connections to the battery voltage.

2. The printed circuit card, control relays and the display card or annunciator.

The printed circuit card monitors the voltage levels from the sensors and from the switch on the annunciator. When a fault condition occurs, the control card flashes the appropriate annunciator LED, turns on the alarm signal, and controls relays to produce an orderly shut down.

3. The actuators or solenoids, including the battery relay.

The three solenoids control the battery or high current relay, the governor fuel valve, and the air intake valve. These are in turn controlled by the three relays.

The following describes the sequence of operations from 'POWER ON' to 'SHUT DOWN':

1. The relay is de-energized and there is no power through the contacts to energize the battery relay. Neither the engine system nor the controller are 'live'.
2. When the operator pushes and releases the power 'RE-SET' button on the annunciator, the controller energizes the relay to provide power for the controller and for the battery relay solenoid. The power is therefore provided to the rest of the engine electrical system. The controller also flashes the annunciator 'SHUT DOWN' display, and performs an internal re-set which disables the sensor inputs. At this time, the 'KEY' switch may be closed by turning the switch to the 'ACC' position to allow operation of lights, radios, etc.
   When turned off, the controller will detect the open 'KEY' switch and immediately de-energize the relay. This removes power to the controller, the battery relay solenoid, and the engine electrical system.
3. When the 'KEY' switch and 'START' switch are both closed to energize the starter motor, the controller card disables the sensor inputs. This provides time for the engine oil pressure to come up to operating level. After the 15 seconds delay following the release of the momentary contact start switch, all sensor inputs are enabled. If the engine has not started at this time, then an 'OIL' shut-down sequence will take place. If, in another attempt to start the engine, the start switch is closed again during the 15 second interval, then no shut-down sequence will occur, and another 15 second delay will be added following the release of the start switch, before the sensors will be enabled.

4. There are three different responses of the controller to sensor inputs:
   - The system requires immediate shut-down of the engine and will ignore an operator request to override the sequence. The sensors associated with this response are 'FIRE', 'GAS', 'TILT', and 'KEY'.
   - The system allows a delayed shut down, in which 15 seconds are allowed to elapse before the shut down sequence begins. During this 15 second period, the system also allows the operator to push the 'OVERRIDE' button. This causes the system to wait another 15 seconds from the time the button was pushed, before initiating the shut-down sequence. The sensors which operate in this manner are the 'WATER LEVEL', 'WATER TEMPERATURE', 'OIL PRESSURE', and 'OVER SPEED'.
   - The sensors do not cause shut down, but produce a display of sensor status on the annunciator, or modify the operation or effects of the sensor inputs. The 'CRANKCASE' pressure sensor is of this type, and produces only a display on the annunciator.

   All sensors, except 'KEY', 'CRANKCASE', and 'MOTION', cause the operation of the audible alarm in the annunciator. All sensors produce a flashing display on the annunciator, with the exception of 'MOTION' and 'CRANKCASE', which produce a steady illumination of the associated section of the display.
5. Once a sensor has detected a dangerous operating condition, the appropriate section of the display has been energized to signal the condition, and no overrides are possible. The actual shut down sequence begins.

Sensors

Each of the sensors, with the exception of 'MOTION', closes a contact between either ground or battery voltage and the controller card input when a dangerous condition exist. If the sensor can not actuate a relay or close a contact, then a sensor control is used to provide the contact closure required by the controller input. The 'MOTION' sensor controller opens a contact when the vehicle speed exceeds 10 km/h.

The following sensors were installed at the trucks in Smoky River mine:

Tilt

Only one sensor was required. An internal contact closes when the vehicle tips over more than 60 degrees.

Water Temperature

An internal contact closes when the temperature exceed determined limit.

Water Level

This sensor appears to the controller as a small resistance when it is covered with water, and as a high resistance when the engine level drops. The controller closes a relay contact when it detects the high resistance.

Gas

The sensor is a semi-conductor device which changes its conductivity in the presence of dangerous concentration of such gases as methane, propane, and natural gas.

Bearing Temperature

The sensor used is a thermistor which changes resistance sharply when its temperature and that of the bearing exceed a pre-set limit.

Pre-Cleaner

This sensor has no controller. It provides its own contact closure when the air cleaner/filter becomes clogged.

Crankcase

Excessive crankcase pressure forces a pair of contacts within the sensor to close.

Fire

This sensor is a bi-metal strip which forces contacts to close when it exceeds a certain temperature. No controller is required.

Motion

The sensor acts like a small AC generator by producing a pulse each time a piece of metal passes in front of it (a gear tooth, for example). A high frequency of pulse generation corresponds to a higher vehicle or engine speed. The controller monitors that frequency and opens the required contact, when the frequency exceeds pre-set limit.

Over-Speed

This sensor works in the same manner as the MOTION sensor, with the exception that, above the adjustable limit, a contact closes.

Oil Pressure

An internal contact closes if the oil pressure drops below a pre-set value.

LEGALOADER SYSTEM

Description

The Legaloader III is an electronic instrument that measures weight of material being loaded with a front end loader or other hydraulic lifting equipment. The Legaloader uses a pressure transducer tapped into the main hydraulic system that provides the Legaloader with an electronic signal, converted into a digital display. A data accumulator allows the measurement of several buckets full of material.

On the front panel of the Legaloader are four switches, one calibration dial, two sets of displays, a fuse holder and two connectors. When the zero toggle switch is pressed, the system memorizes the weight of the empty bucket and automatically subtracts this weight from future loads. The calibration dial is used to calibrate the instrument so that the bucket displays are read in imperial or metric units.

The loader operator must establish a reproducible "weighing position". This is an arbitrary point somewhere near the middle of the boom's arc. Normally it is slightly below the height of a standard dump truck. When in the 'weighing position', the centre of gravity of the bucket should be level with the upper lifting boom. Once the operator understands how to use the Legaloader he should be able to determine where he wants the position to be.

Operating Procedures

Calibration and all weighing is done with the bucket tilted all the way back. When the bucket is raised at full RPM past the magnetic switch the bucket display will automatically show the weight of the material in the bucket and will hold this display for up to 20 seconds. It is absolutely imperative that the bucket be raised at the same engine speed while zeroing the empty bucket and while weghing the loaded bucket.

Three steps in the setting procedures are explained:

1. Setting Zero

When pover is applied to the Legaloader, the displays will indicate zero regardless of the bucket's position. For any weight to be displayed, the system is 'zeroed' after the hydraulic fluid has warmed up as follows:

- tilt the bucket all the way back,
- raise the bucket using your full RPM throttle setting,
- after the bucket has passed the 'weighing position' mark, press 'zero' swith, and lover the bucket,
- the bucket is now zeroed.

2. Calibrating

The initial procedure requires an accurate 'test weight'. The bucket must be raised and lowered several times to get the hydraulic fluid up to operating temperature. The calibration is as follows:

- set the calibration dial to approximately 500,
- zero the empty bucket,
- lift the test weight past the 'weighing position',
- adjust the calibration dial so that the correct weight appears on the bucket display,
- repeat this procedure until the correct weight appears in the bucket window,
- raise the bucket past the 'weighing position' several times to be sure the weight is the same.

3. Accumulating

Adding of weight of the material may be accomplished with either the 'ADD' switch on the front panel or by a remote 'ADD' switch mounted close to the vehicle operator, as follows:

- lift a bucket of material past the 'weighing position',
- press the 'ADD' switch within 20 seconds,
- load the material and repeat this for a new bucket.

The accumulator can be cleared by pressing the 'RESET' toggle switch.

CONCLUSION

Two equipment monitoring systems used at Smoky River mine are described in this report: Ropec system installed at all mine trucks, and Legaloader system installed at front end loader.

The Ropec is an engine monitoring system that detect and display possible cause of malfunction and, if condition persists, provide warning to the operator and orderly shut-down of the engine. The Ropec system operation and its sensors are described. This system is fully operational at the mine and provide usefull and accurate information. The mine purchased initially two units that were tested under normal operating conditions for several months. After the successful test, all mine trucks were equipped with the system. Mine engineers, operators and maintenance personnel are quite happy with the performance of the system. A study is under way to investigate and record pre- and post-event condition of the equipment to establish reasons for equipment failure and to predict events that are leading to equipment break down. The economics behind the installation and use of the system is not available now. It is understand, the system pay off period is less than six months, by providing tool for better management of the truck fleet and predict equipment failure that may be costly in the future.

The Legaloader is a weight monitoring system for front end loaders. It was installed on one test unit at the mine and was rejected, because of curbersome operation, complicated set-up and testing procedure, and inaccurate measurement.

ACKNOWLEDGEMENT

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